

IN THE SPECIFICATION:

Please amend the specification as follows:

On page 1, just below the title, insert the following:

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to European Application 02256037.9, filed August 30, 2002, the entire contents of which are incorporated herein by reference.

Please amend paragraph [0002] as follows:

[0002] The term "patterning device" as here employed should be broadly interpreted as referring to device that can be used to endow an incoming radiation beam with a patterned cross-section, corresponding to a pattern that is to be created in a target portion of the substrate. The term "light valve" can also be used in this context. Generally, the pattern will correspond to a particular functional layer in a device being created in the target portion, such as an integrated circuit or other device (see below). An example of such a patterning device is a mask. The concept of a mask is well known in lithography, and it includes mask types such as binary, alternating phase-shift, and attenuated phase-shift, as well as various hybrid mask types. Placement of such a mask in the radiation beam causes selective transmission (in the case of a transmissive mask) or reflection (in the case of a reflective mask) of the radiation impinging on the mask, according to the pattern on the mask. In the case of a mask, the support structure will generally be a mask table, which ensures that the mask can be held at a desired position in the incoming radiation beam, and that it can be moved relative to the beam if so desired.

Please amend paragraph [0003] as follows:

[0003] Another example of a patterning device is a programmable mirror array. One example of such an array is a matrix-addressable surface having a viscoelastic control layer and a reflective surface. The basic principle behind such an apparatus is that, for example, addressed areas of the reflective surface reflect incident light as diffracted light, whereas unaddressed areas reflect incident light as undiffracted light. Using an appropriate filter, the undiffracted light can be filtered out of the reflected beam, leaving only the diffracted light behind. In this manner, the beam becomes patterned according to the addressing pattern of the matrix-addressable surface. An alternative embodiment of a programmable mirror array employs a matrix arrangement of tiny mirrors, each of which can be individually tilted about

an axis by applying a suitable localized electric field, or by employing piezoelectric actuators. Once again, the mirrors are matrix-addressable, such that addressed mirrors will reflect an incoming radiation beam in a different direction to unaddressed mirrors. In this manner, the reflected beam is patterned according to the addressing pattern of the matrix-addressable mirrors. The required matrix addressing can be performed using suitable electronics. In both of the situations described hereabove, the patterning device can comprise one or more programmable mirror arrays. More information on mirror arrays as here referred to can be seen, for example, from U.S. Patents 5,296,891 and 5,523,193, and WO 98/38597 and WO 98/33096. In the case of a programmable mirror array, the support ~~structure~~ may be embodied as a frame or table, for example, which may be fixed or movable as required.

Please amend paragraph [0004] as follows:

[0004] Another example of a patterning device is a programmable LCD array. An example of such a construction is given in U. S. Patent 5,229,872. As above, the support ~~structure~~ in this case may be embodied as a frame or table, for example, which may be fixed or movable as required.

Please amend paragraph [0006] as follows:

[0006] Lithographic projection apparatus can be used, for example, in the manufacture of integrated circuits (ICs). In such a case, the patterning device may generate a circuit pattern corresponding to an individual layer of the IC, and this pattern can be imaged onto a target portion (e.g. comprising one or more dies) on a substrate (silicon wafer) that has been coated with a layer of radiation-sensitive material (resist). In general, a single wafer will contain a whole network of adjacent target portions that are successively irradiated via the projection system, one at a time. In current apparatus, employing patterning by a mask on a mask table, a distinction can be made between two different types of machine. In one type of lithographic projection apparatus, each target portion is irradiated by exposing the entire mask pattern onto the target portion at once. Such an apparatus is commonly referred to as a wafer stepper. In an alternative apparatus, commonly referred to as a step-and-scan apparatus, each target portion is irradiated by progressively scanning the mask pattern under the ~~projection~~ beam in a given reference direction (the "scanning" direction) while synchronously scanning the substrate table parallel or anti-parallel to this direction. Since, in general, the projection system will have a magnification factor M (generally < 1), the speed V at which the substrate table is scanned will be a factor M times that at which the mask table is

scanned. More information with regard to lithographic devices as here described can be seen, for example, from U.S. Patent 6,046,792.

Please amend paragraph [0010] as follows:

[0010] Alternatively, one of the reflectors in the apparatus may be partially silvered, allowing a portion of the incident radiation to pass through the reflector to a sensor behind the reflector, or may redirect a portion of the beam to a sensor. This arrangement intrinsically reduces the intensity of the ~~projection~~ beam, which in turn reduces the throughput of the apparatus. Apparatus using EUV radiation are especially sensitive to this problem since EUV reflectors are naturally very inefficient. High reflectivity mirrors for EUV radiation are not currently available. Furthermore, in lithographic projection apparatus employing EUV radiation, the ~~projection~~ beam is radiated in an evacuated system to prevent losses in intensity. Therefore the beam intensity sensors must also be located within the evacuated system and must therefore be designed to be vacuum tolerant and to not outgas when placed in the vacuum.

Please amend paragraph [0011] as follows:

[0011] It is an aspect of the present invention to provide a device to determine the intensity of the ~~projection~~ radiation beam that can determine the intensity of the beam across its cross-sectional area and is compatible for use with EUV apparatus.

Please amend paragraph [0012] as follows:

[0012] This and other aspects are achieved according to the present invention in a lithographic apparatus including a radiation system configured to provide an unpatterned ~~projection~~ beam of radiation; a support configured to support a patterning device, the patterning device configured to pattern the unpatterned ~~projection~~ beam according to a desired pattern; a substrate table configured to hold a substrate; a projection system configured to project the patterned ~~projection~~ beam onto a target portion of the substrate; a sensor configured to detect luminescent radiation radiated by at least one region of an area on a component of the apparatus traversed by the unpatterned ~~projection~~ beam or the patterned ~~projection~~ beam, and a control device configured to determine the intensity, in the at least one region, of the unpatterned ~~projection~~ beam or the patterned ~~projection~~ beam from the detected luminescent radiation.

Please amend paragraph [0013] as follows:

[0013] According to another aspect, the sensor detects the luminescent radiation from a plurality of regions of the area on the component on which the unpatterned ~~projection~~ beam or the patterned ~~projection~~ beam is incident and the control device determines the intensity of the unpatterned ~~projection~~ beam or the patterned beam in each of the regions.

Please amend paragraph [0014] as follows:

[0014] The intensity, in the region, of the unpatterned ~~projection~~ beam or the patterned projection beam may be determined from the detected luminescent radiation. Luminescence is the spontaneous emission of radiation from a thermally excited substance. Several different types of luminescence are known and identified based upon the mechanism by which the thermally excited state is created, for example photoluminescence (the excited state is produced by the absorption of photons), radioluminescence (arising from excitation by high-energy particles or radiation), sonoluminescence (arising from excitation by sound waves), triboluminescence (arising from the rubbing together of the surface of certain solids) and chemiluminescence (arising from a chemical reaction). Additionally, the luminescence can also be identified by the relationship between excitation and emission, for example fluorescence (emission occurs only during the excitation of a substance) and phosphorescence (emission occurs or continues after excitation of a substance has ceased).

Please amend paragraph [0015] as follows:

[0015] The degree of luminescence (presumably caused by state transitions of the atoms in the surface induced by the incident beam of radiation) produced by a component of the apparatus by the incidence of the ~~projection~~ beam is determined by several factors including the properties of the incident energy beam (for example photon energy and wavelength) and the properties of the component (for example the materials used).

Please amend paragraph [0017] as follows:

[0017] The element from which the luminescent radiation is detected may be a multilayer stack forming a distributed Bragg reflector or a grazing-incidence collector. In particular, the element may be part of the projection system and/or part of the radiation system and/or may be the first reflector on which the unpatterned ~~projection~~ beam is incident. The element may also be part of the illuminator.

Please amend paragraph [0019] as follows:

[0019] Since the ~~projection~~ radiation beam is EUV radiation, the patterning device, the projection system, the substrate, and at least part of the radiation system are contained in an evacuated chamber to reduce losses in beam intensity due to absorption of the EUV radiation. However, since the luminescent radiation will be at a different wavelength, for example within the visible spectrum, it will not be absorbed to the same extent as the EUV radiation. In a preferred embodiment, therefore, the sensor can be located outside of the evacuated chamber. Consequently the sensor does not need to be vacuum compatible.

Please amend paragraph [0020] as follows:

[0020] The determined intensity of the region(s) of the unpatterned ~~projection~~ radiation beam or the patterned ~~projection~~ radiation beam from which the luminescent radiation is detected may be used to adjust the exposure time of the target portion of the substrate, the intensity of the unpatterned ~~projection~~ beam of radiation produced by the radiation system, and/or the intensity of the patterned ~~projection~~ beam.

Please amend paragraph [0021] as follows:

[0021] According to a further aspect of the invention there is provided a device manufacturing method including ~~providing a substrate that is at least partially covered by a layer of radiation-sensitive material;~~ providing an unpatterned ~~projection~~ beam of radiation using a radiation system; projecting a patterned ~~projection~~ beam of radiation onto a target portion of ~~[[the]]~~ a layer of radiation-sensitive material at least partially covering a substrate; and detecting luminescent radiation radiated by at least one region of an area on a component traversed by the unpatterned ~~projection~~ beam or the patterned ~~projection~~ beam on which the beam is incident; and determining the intensity, in the at least one region, of the unpatterned ~~projection~~ beam or the patterned ~~projection~~ beam from the detected luminescent radiation.

Please amend paragraph [0022] as follows:

[0022] According to another aspect, the method includes detecting the luminescent radiation from a plurality of regions of the area on the component on which the unpatterned ~~projection~~ beam or the patterned ~~projection~~ beam is incident, and determining the intensity of the unpatterned ~~projection~~ beam or the patterned ~~projection~~ beam in each of the regions.

Please amend paragraph [0032] as follows:

[0032] The source LA (e.g. a discharge or laser-produced plasma source) produces radiation. This radiation is fed into an illumination system (illuminator) IL, either directly or after having traversed a conditioning device, such as a beam expander Ex, for example. The illuminator IL may comprise an adjusting device AM configured to set the outer and/or inner radial extent (commonly referred to as σ -outer and σ -inner, respectively) of the intensity distribution in the ~~projection~~ beam PB. In addition, it will generally comprise various other components, such as an integrator IN and a condenser CO. In this way, the ~~projection~~ beam PB impinging on the mask MA has a desired uniformity and intensity distribution in its cross-section.

Please amend paragraph [0034] as follows:

[0034] The beam PB subsequently intercepts the mask MA, which is held on a mask table MT. Having traversed the mask MA, the beam PB passes through the lens PL, which focuses the beam PB onto a target portion C of the substrate W. With the aid of the second positioning device PW and interferometer(s) IF, the substrate table WT can be moved accurately, e.g. so as to position different target portions C in the path of the beam PB. Similarly, the first positioning device PM can be used to accurately position the mask MA with respect to the path of the beam PB, e.g. after mechanical retrieval of the mask MA from a mask library, or during a scan. In general, movement of the object tables MT, WT will be realized with the aid of a long-stroke module (coarse positioning) and a short-stroke module (fine positioning), which are not explicitly depicted in Figure 1. However, in the case of a wafer stepper (as opposed to a step and scan apparatus) the mask table MT may just be connected to a short stroke actuator, or may be fixed. The mask MA and the substrate W may be aligned using mask alignment marks M_1 , M_2 and substrate alignment marks P_1 , P_2 .

1. The depicted apparatus can be used in two different modes:
In step mode, the mask table MT is kept essentially stationary, and an entire mask image is projected at once, i.e. a single "flash," onto a target portion C. The substrate table WT is then shifted in the X and/or Y directions so that a different target portion C can be irradiated by the beam PB;
2. In scan mode, essentially the same scenario applies, except that a given target portion C is not exposed in a single "flash." Instead, the mask table MT is movable in a given direction (the so-called "scan direction," e.g., the Y direction) with a speed v , so that the

~~projection~~ beam PB is caused to scan over a mask image. Concurrently, the substrate table WT is simultaneously moved in the same or opposite direction at a speed $V = Mv$, in which M is the magnification of the lens PL (typically, $M = 1/4$ or $1/5$). In this manner, a relatively large target portion C can be exposed, without having to compromise on resolution.

Please amend paragraph [0037] as follows:

[0037] The sensor 4 may detect the luminescent radiation 5 from the entire surface area 3a of the reflector 3 on which the beam of radiation 2 is incident. Alternatively, with the use of appropriate optics, such as a lens 6, the image of the surface area 3a of the reflector 3 on which the beam of radiation 2 is incident may be projected onto the sensor 4. The sensor 4 can then be used to monitor the intensity of the beam of radiation over its cross-section. This is useful as, in a ~~projection~~ radiation beam for example, it is desirable to ensure that the beam intensity is uniform across its cross-section.

Please amend paragraph [0040] as follows:

[0040] The sensor may be used in conjunction with any surface on which a beam of radiation is incident. In particular, it may be used with the unpatterned ~~projection~~ beam of radiation or the patterned ~~projection~~ beam. In the case of the former, the sensor 4 is preferably used in conjunction with a reflector 3 that is close to the radiation source. At each reflection, the intensity of the beam of radiation 2 decreases and hence the amount of luminescent radiation irradiated from each surface decreases. The sensor may therefore be used in conjunction with a reflector that is part of the radiation system or immediately down-beam of the radiation system.

Please amend paragraph [0041] as follows:

[0041] In particular, the sensor may be used in conjunction with field and/or pupil faceted mirrors in the illumination system. These are used to improve the uniformity of the intensity over the cross section of the ~~projection~~ beams. The facet mirrors may need to be adjusted to attain the required field intensity distribution. The sensor can be used to determine the intensity distribution of the ~~projection~~ beam either at the facet mirrors or at a subsequent element. The required adjustments to the facet mirrors can therefore be determined. Further information on field and pupil facet mirrors is explained in ~~European~~ Patent 6,771,352 Application No. 02251933.4.

Please amend paragraph [0043] as follows:

[0043]The sensor 4 may also be used in conjunction with a reflector 3 in the projection system. Since no suitable material for manufacturing refractive lenses usable with EUV radiation is known, projection systems for lithographic apparatus making use of EUV radiation for the ~~projection~~ beam must be based on reflective optics. An example of such a projection system is shown in Figure 3. The reflectors M₁, M₂, M₃, M₄ are used to project an image of the patterning device MA onto the substrate W. Further information on projection systems using reflective optics may be found in ~~EP 1 209 503A~~ U.S. Patent No. 6,556,648.